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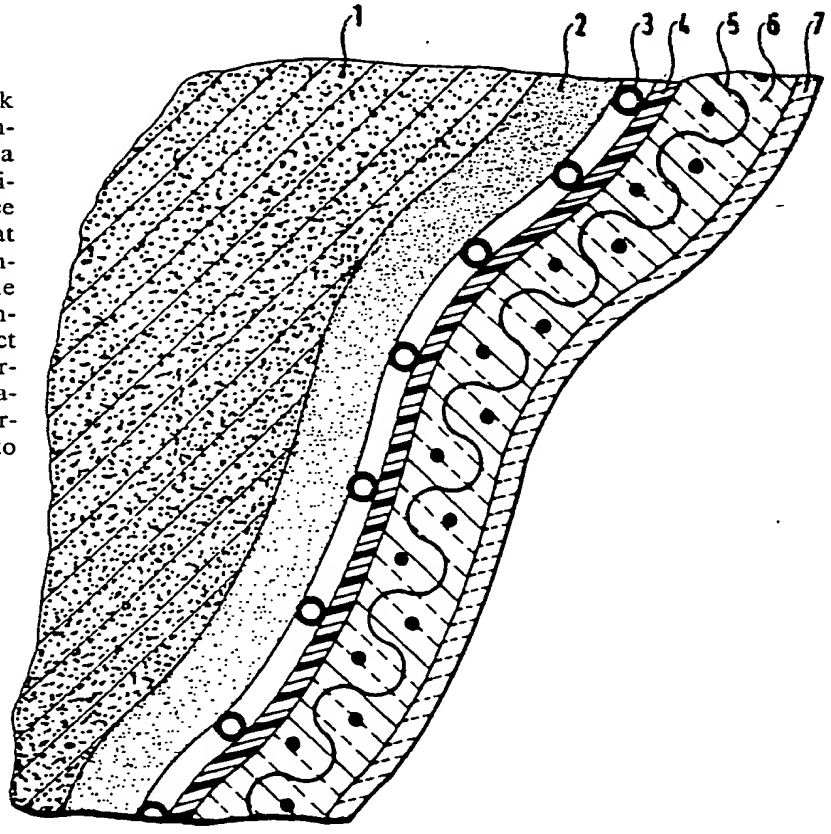
(57) Abstract

System for the insulation of tunnels, rock cavities and similar mining installations, in conjunction with which a draining layer (3) and a waterproof membrane (4) are installed immediately adjacent to the rock (1) or on the surface of a reinforcing layer (2) applied thereto, so that they follow the contours of the rock or the reinforcing layer. The insulating system reduces the risk of water freezing to form ice in mining installations. Thermal insulation (6) to counteract frost is installed on the surface of the waterproof membrane (4), and fire-retardant insulation (7) is installed on the surface of said thermal insulation (6). The invention also relates to a method for implementing the system.



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System for the insulation of mining installations and a method for implementing the system

The present invention relates to a system for the insulation of tunnels, rock cavities and similar mining installations, in conjunction with which a draining layer and a waterproof membrane are installed immediately adjacent to the rock or on the surface of a reinforcing layer applied thereto, so that they follow the contours of the rock or the reinforcing layer.

The invention also relates to a method for implementing the insulation system for the insulation of tunnels, rock cavities and similar mining installations, in conjunction with which a draining layer and a waterproof membrane are installed immediately adjacent to the rock or on the surface of a reinforcing layer applied thereto, so that they follow the contours of the rock or the reinforcing layer.

Wherever water-bearing fissures pass through mining installations, tunnels, rock cavities and open cuts, etc., water is present in the form of moisture, drops or running/sprinkling water. This water can freeze in the winter. Undulating ice and icicles are then formed. This phenomenon occurs in those parts of a mining installation where the air temperature falls below the freezing point. Examples of those mining installations where this occurs are the outer parts of transport tunnels (tunnels which run from the surface down to a main tunnel) and rail and road tunnels which are open at both ends and thus permit cold air to flow into and through the tunnel. This phenomenon frequently occurs in rock cuttings along highways.

The formation of ice poses major problems. In many cases the ice encroaches upon the free clearance for the vehicles in rail and road tunnels, for example. This results in disruptions to the traffic. As the air temperature rises, the ice thaws and drops down. Equipment, vehicles and people, etc., can suffer damage and injury.

The ice must be chipped away (cleared) continuously in order to eliminate the risk of damage and to

maintain the function of the installation. Ice clearance work is both dangerous and costly. Deaths have occurred in Sweden in conjunction with ice clearance. Considerable sums are spent every year on ice clearance work. Ice clearance usually means that a road tunnel, for example, must be closed either completely or partially. The result is the disruption of traffic.

The formation of ice also affects the rock and any reinforcements in the installation. Blocks of rock can fall down when the water in a fissure freezes and forces out the block. Reinforcements made of sprayed concrete and poured concrete suffer frost damage as a result of rupture due to frost. This results in a reduced service life and in increased maintenance and repair costs.

In summary, therefore, the formation of ice in mining installations gives rise to major problems associated with restricted use, the risk of damage, reduced service life and increased costs of maintenance and repair work. Continuous ice clearance is necessary, and this is both dangerous and costly.

A number of different systems are currently available for solving the problem of ice formation. For example, insulated vaults made of plastic and sheet metal are installed inside tunnels. The disadvantages associated with these vaults are, for example, that they require a certain amount of space, which means that an increased tunnel cross-section must be blasted, or that inroads must be made on the free space for the traffic, for example. They are also expensive, and they involve long delivery and installation periods (prefabrication for different sizes of tunnel). The fire prevention authorities have also begun to adopt a negative attitude towards plastic vaults in traffic tunnels where vehicle fires, for instance, can occur. Extruded cellular plastic matting has also been used. Generally speaking, this system exhibits the same disadvantages as those outlined above for the vaults. Experiments have also been conducted into heating the air, in this way preventing freezing. This is a very expensive method, however, and is susceptible to plant breakdown. Insulated drains are sometimes used locally. More

often than not these produce a poor effect, since any water leakage due to blockages has to be removed from the area which has already been drained by the drains. Furthermore, such local applications provide poor protection against the cold.

The principal object of the present invention is thus to prevent ice formation and to permit the advancing water to be led away in a drainage system. At the same time the invention must take up the smallest possible space, require a short installation period and be flexible (ease of adaptation to other tunnel cross-sections, etc.). The invention must also be suitable for use not only for the complete insulation of a mining installation, but also for the partial insulation of an installation.

The rock itself maintains a comparatively even temperature of about +5°C throughout the year. The water which finds its way through the fissures in principle exhibits the same temperature as the surrounding rock. The aim of the invention is thus to prevent the cold air from cooling down the rock and the water.

Said object is achieved by means of a method in accordance with the present invention, which is characterized essentially in that thermal insulation to counteract frost is installed on the surface of the waterproof membrane, and in that fire-retardant insulation is installed on the surface of said thermal insulation.

A further object of the present invention is to disclose a method for making available a system for the insulation of tunnels, rock cavities and similar mining installations, in conjunction with which a draining layer and a waterproof membrane are installed immediately adjacent to the rock or on the surface of a reinforcing layer applied thereto, so that they follow the contours of the rock or the reinforcing layer.

Said further object is achieved by means of a method in accordance with the present invention, which is characterized essentially in that thermal insulation is installed on the surface of the waterproof membrane for the purpose of

counteracting frost, and in that fire-retardant insulation is installed on the surface of the thermal insulation.

The invention is described below in relation to two illustrative embodiments, in conjunction with which reference is made to the drawings, in which:

Fig. 1 shows a first illustrative embodiment of an insulating system; and

Fig. 2 shows a second illustrative embodiment of an insulating system.

The invention consists of a number of components which are combined to produce a system for the frost insulation of mining installations. The system consists of the following components and is composed in the following manner. Installed immediately adjacent to the rock 1 or on the outside of a reinforcing layer 2 are, on the one hand, a draining layer 3 and, on the other hand, a waterproof membrane 4. The water is led away via the draining layer 3 to a drainage pipe which takes the water out of the installation. The draining layer 3 and the waterproof membrane 4 are installed close up against the rock 1 or the reinforcing layer 2, so that they follow the contours of the rock, requiring a minimum of space. This method has been used for many years for the removal of water, in so doing preventing dropping water and running water, etc., although no frost insulation is achieved in this design.

It is proposed in accordance with the present invention to supplement the basic system with thermal insulation 6 in the following way, in so doing preventing frost formation. A reinforcing mesh 5 can be attached to the surface of the waterproof membrane 4. Thermal insulation 5 consisting, for example, of polyurethane is then applied by spraying or by some other appropriate method. The reinforcing mesh 5 functions, where it is used, as a reinforcement inside the insulating layer, in this way producing a stable, insulating layer. The thickness of the insulation is simply varied depending on the air temperature with which the system is required to contend.

A fire-resistant material 7 is applied to the

outside of the thermal insulation 5, 6 in order to provide fire-proofing. The nature of the fire-resistant layer 7 may vary to suit the various requirements of the fire prevention authorities. A thin layer of fire-retardant plaster can usually be applied on the outside of the thermal insulation 5, 6.

In the case of rock 1 which exhibits a very uneven contour, it is possible first to install a smoothing mesh 8 on the surface of the rock 1 or the sprayed concrete 2 for the purpose of evening out the contours, and to let this mesh 8 form part of the reinforcing layer 2. The system as previously described is then applied to the surface of mesh 8, as shown in Fig. 2, with a draining layer 3, a waterproof membrane 4 followed by reinforcement 5, if required, and by thermal insulation 6, and a fire-retardant layer 7.

The frost insulating system thus consists of a number of components, all of which are available by length or by weight. The system is built up simply directly on site and can be adapted to suit different tunnel cross-sections and different requirements, etc. As it follows the contour of the rock, a minimum of space is required. The method by which it is applied is also suitable for systematic handling, so that not only entire mining installations, but also parts of mining installations can be insulated.

Further advantages include the fact that existing systems for the removal of water can be supplemented easily with thermal frost insulation, so that the water which is leaking into the workings will not freeze;

- that it can be constructed from a number of components, which are applied directly on site;
- that it can be used in all kinds of mining installation, irrespective of their size and form, etc.;
- that the nature of the insulation can be varied depending on the external temperature with which the system is to contend;
- that it a flexible system which follows the surface of the rock and thus takes up a minimum amount of space; and

– that it can be provided with various kinds of fire protection.

The invention is not restricted to the illustrative embodiments described above and illustrated in the drawings, but may be varied within the scope of the Patent Claims without departing from the idea of invention.

Patent Claims

1. A system for the insulation of tunnels, rock cavities and similar mining installations, in conjunction with which a draining layer (3) and a waterproof membrane (4) are installed immediately adjacent to the rock (1) or on the surface of a reinforcing layer (2, 8) applied thereto, so that they follow the contours of the rock or the reinforcing layer, characterized in that thermal insulation (6) to counteract frost is installed on the surface of the waterproof membrane (4), and in that fire-retardant insulation (7) is installed on the surface of said thermal insulation (6).

2. A system in accordance with Patent Claim 1, characterized in that the thermal insulation (6) is applied by spraying onto the surface of the waterproof membrane (4).

3. A system in accordance with Patent Claim 2, characterized in that a reinforcing mesh (5) is secured to the surface of the waterproof membrane (4), around which mesh the thermal insulation (6) is applied by spraying.

4. A system in accordance with any of the preceding Patent Claims, characterized in that the thermal insulation (6) consists of polyurethane.

5. A system in accordance with any of the preceding Patent Claims, characterized in that the fire-retardant insulation (7) consists of plaster.

6. A method for implementing a system in accordance with any of the preceding Patent Claims for the insulation of tunnels, rock cavities and similar mining installations, in conjunction with which a draining layer (3) and a waterproof membrane (4) are installed immediately adjacent to the rock (1) or on the surface of a reinforcing layer (2, 8) applied thereto, so that they follow the contours of the rock or the reinforcing layer, characterized in that thermal insulation (6) is installed on the surface of the waterproof membrane (4) for the purpose of counteracting frost, and in that fire-retardant

insulation (7) is installed on the surface of the thermal insulation (6).

7. A method in accordance with Patent Claim 6, characterized in that the thermal insulation (6) is applied by spraying onto the surface of the waterproof membrane (4).

8. A method in accordance with any of the Patent Claims 6–7, characterized in that a reinforcing mesh (5) is secured to the surface of the waterproof membrane (4), whereupon the thermal insulation (6) is applied around said mesh (5) by spraying.

9. A method in accordance with any of the Patent Claims 7–8, characterized in that polyurethane is applied by spraying in order to form said thermal insulation (6).

10. A method in accordance with any of the Patent Claims 6–9, characterized in that fire–retardant insulation (7) in the form of plaster is installed on the surface of the thermal insulation (6).

11. A method in accordance with any of the Patent Claims 6–10, characterized in that the system is applied directly on site, and in that parts of or entire mining installations are insulated, in conjunction with which, for example, the thermal frost–protecting insulation (5, 6) is installed over existing water–removing drainage layers (3) and waterproof membranes (4).

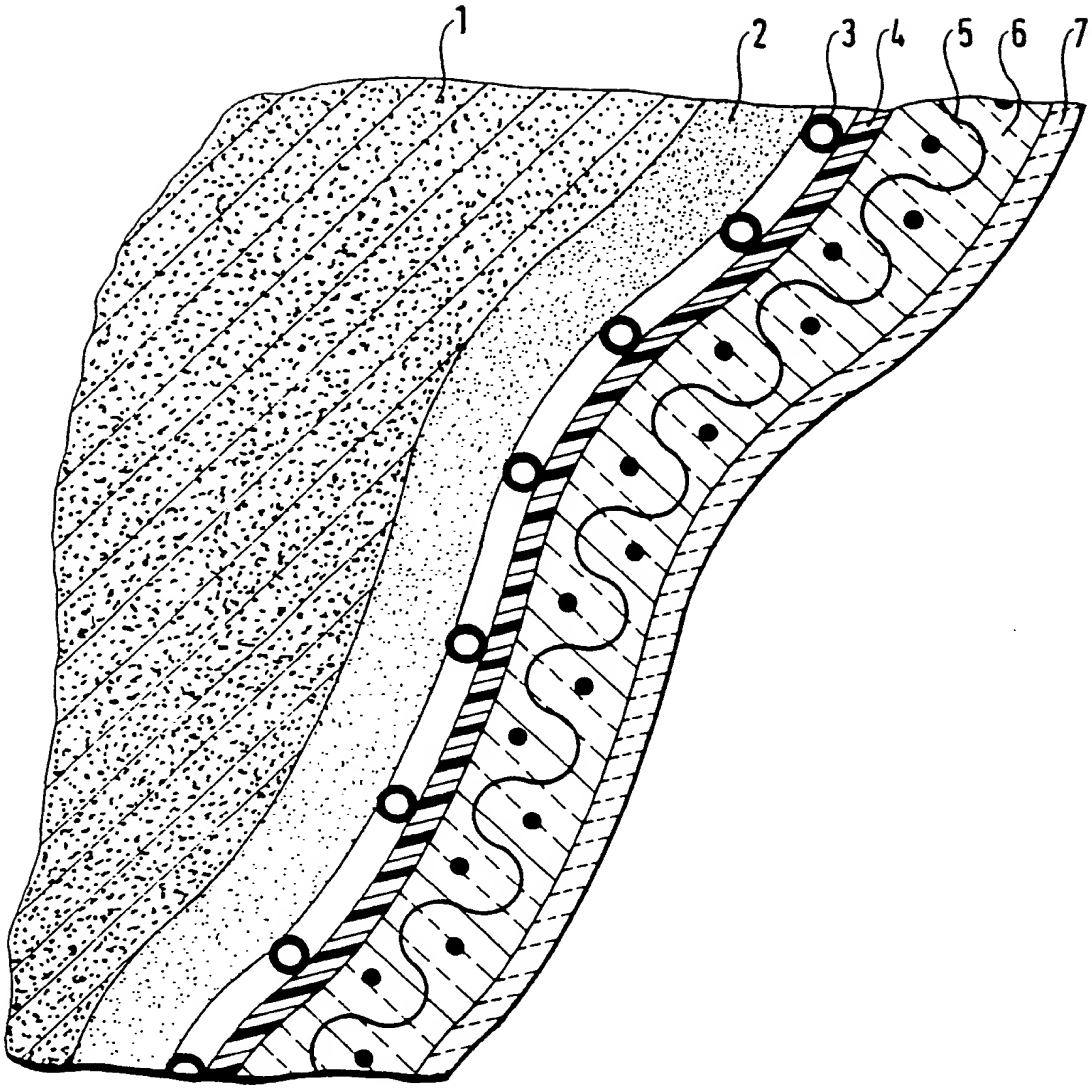

Fig. 1

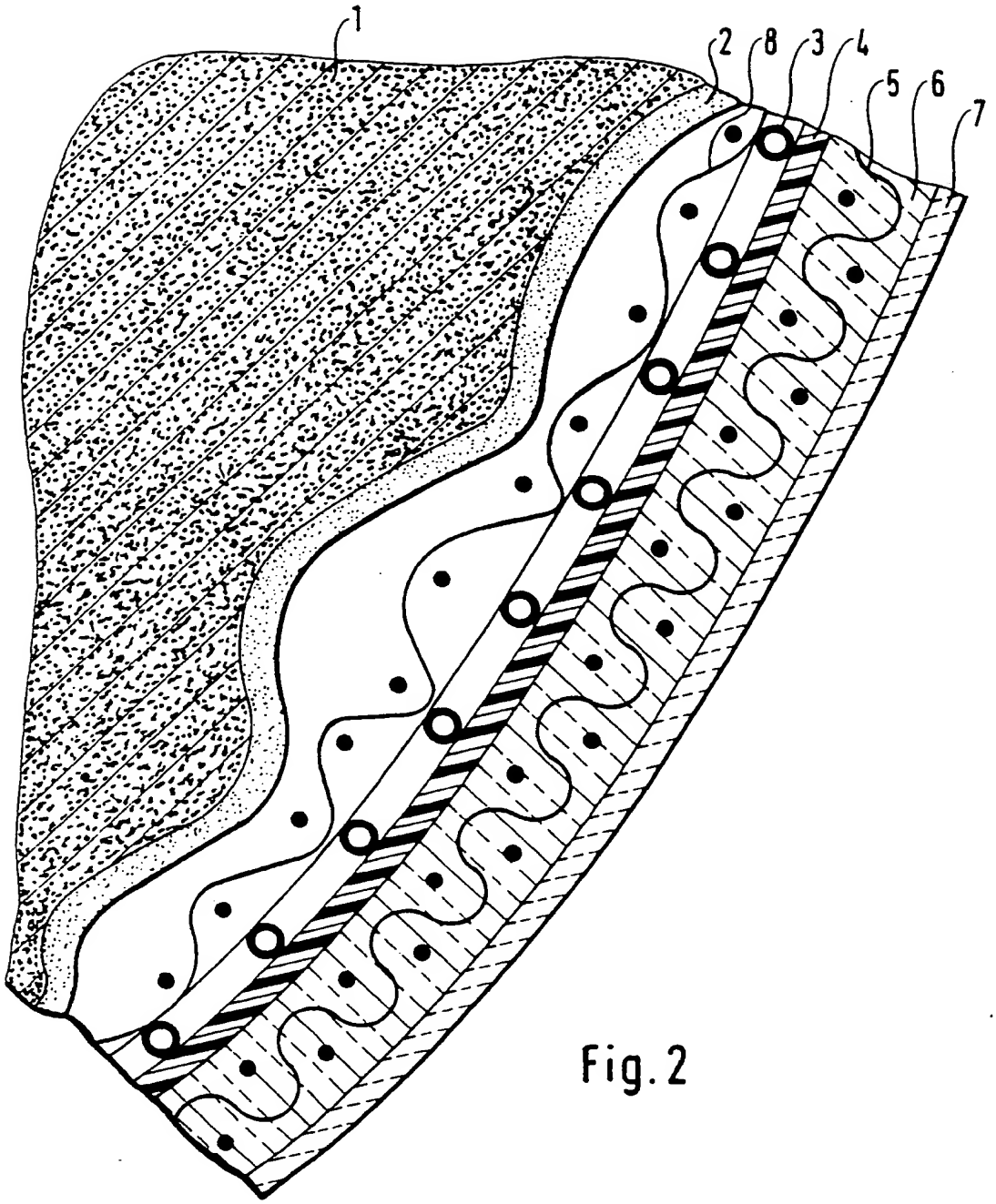

Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00063

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

E 21 D 11/38

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	B 65 G 5/00; E 02 D 31/00-/04, /14; E 03 B 7/12; E 21 D 11/00, /10, /38, 13/00-/04; E 21 F 17/16
US Cl	61: 39, 42, 45; 405: 150-153, 284-287

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	AT, B, 370 850 (SEEBODE, GERHARD) 10 May 1983	1-11
A	DE, B2, 2 532 664 (ISO-BAU ABDICHTUNGEN IM HOCH- UND TIEFBAU GMBH) 5 May 1977	1-11
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IV. CERTIFICATION

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Swedish Patent Office	Bertil Dahl

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